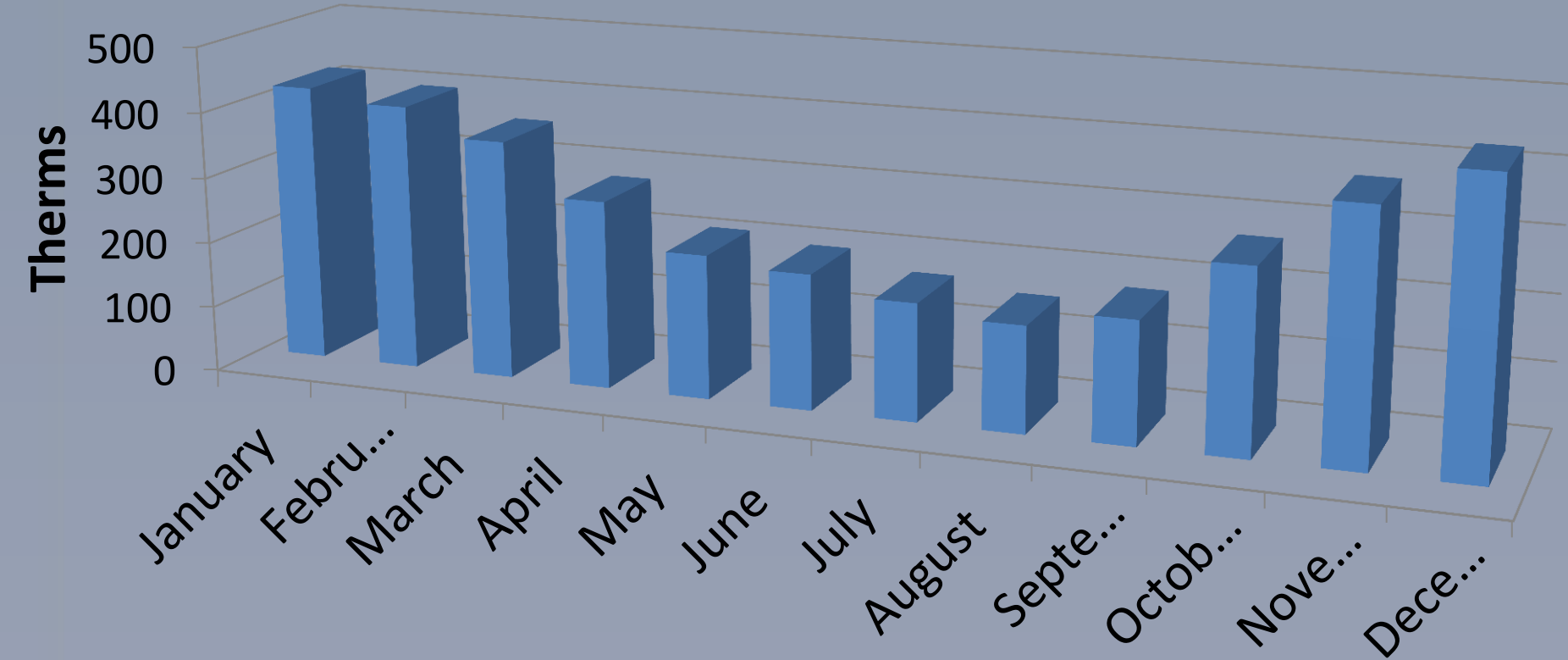


## Step 1: System Qualification

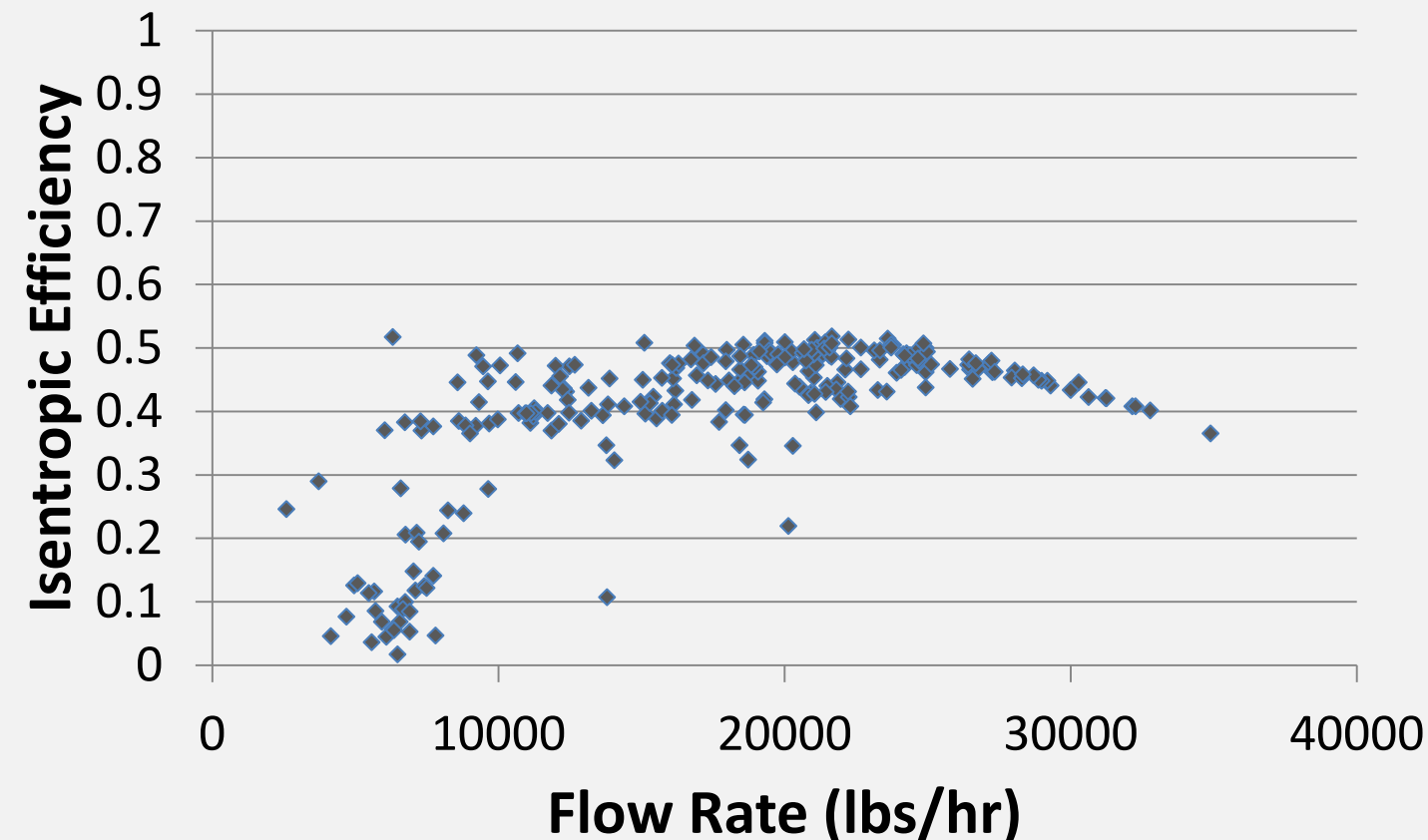
The Department of Energy recommends cogeneration for a facility with a large, constant heating load and a centralized plant.

Campus Hourly Heating Requirement



The UI Steam Plant central heating facility supplies a typical annual heating load of ~2.5 million therms.

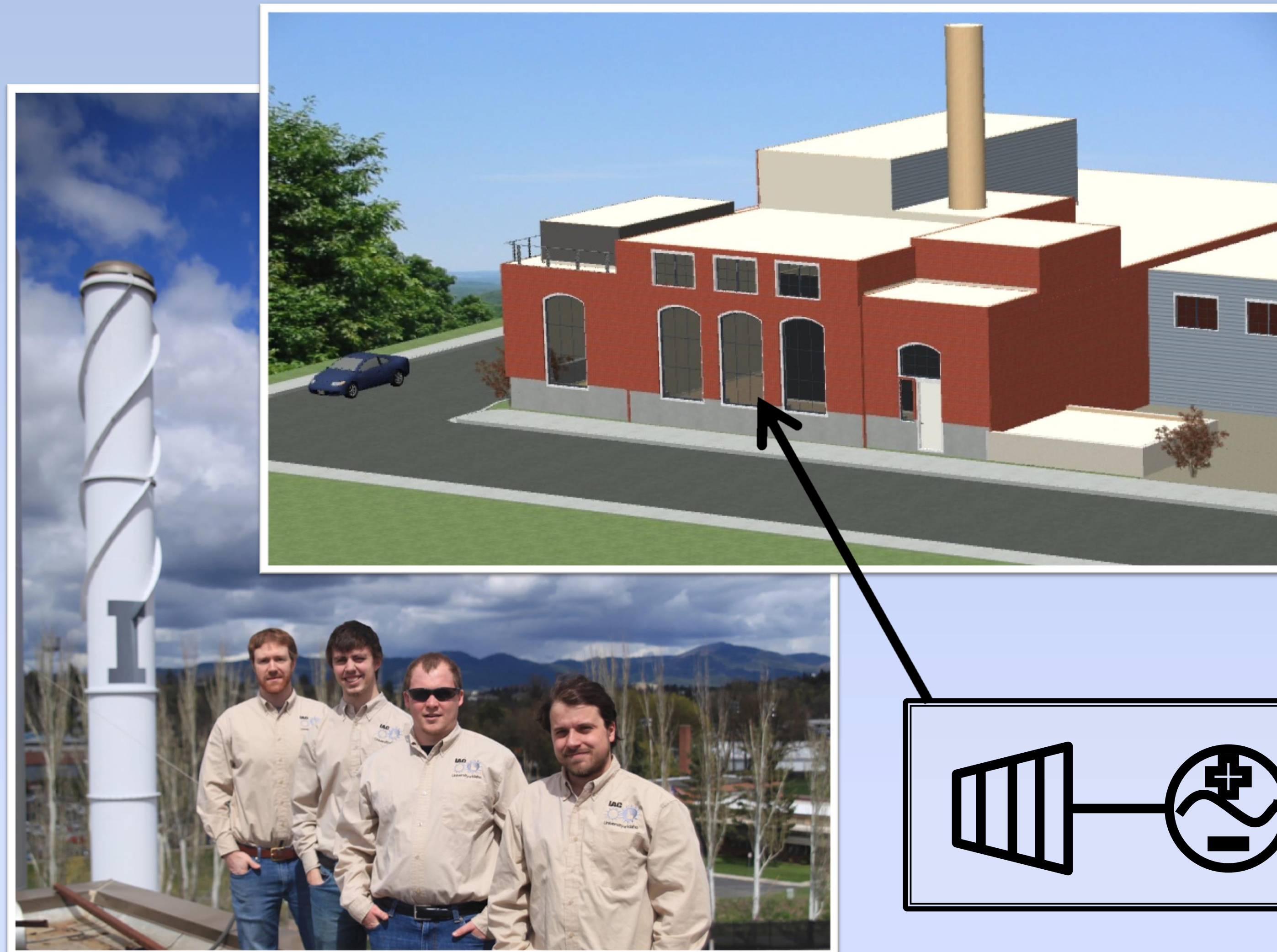
Benchmark Turbine Performance (Univ. of MT)



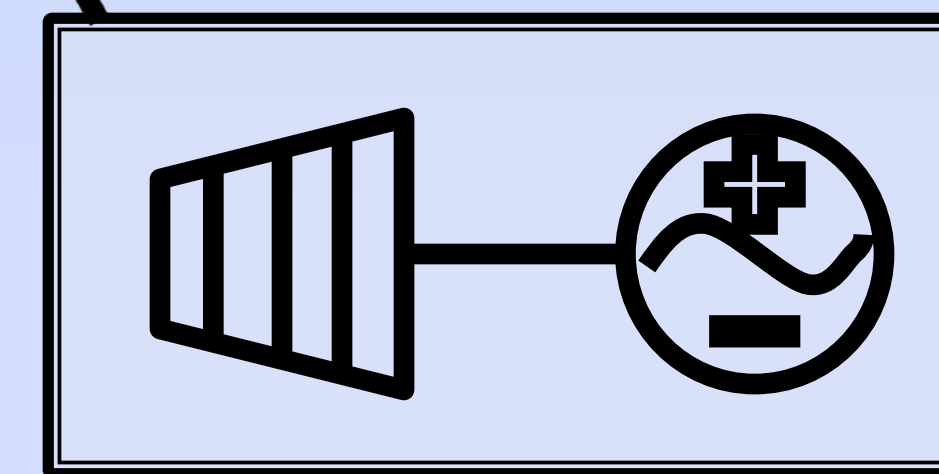
Method for estimating turbine isentropic efficiency was validated with data from the existing cogeneration turbine at the University of Montana.

## Feasibility Study:

*An assessment of cogeneration from a renewable energy source at the University of Idaho Steam Plant*

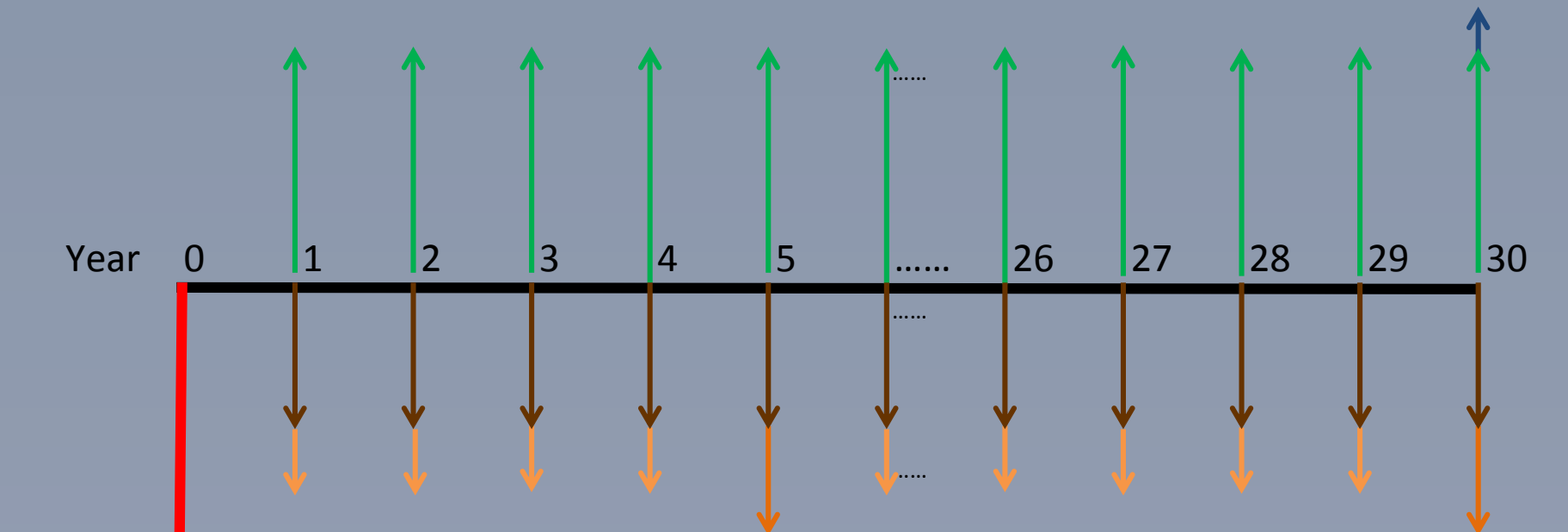


**Team members (left to right):** Ryan Oliver, Chris Anderson, Donald Haines, Chad Dunkel  
**Advisors:** Scott Smith, Dr. Tao Xing, Dr. Steve Beyerlein, Dr. Herb Hess, Dr. Dev Shrestha, Amrit Dahal



## Step 3: Economic Analysis

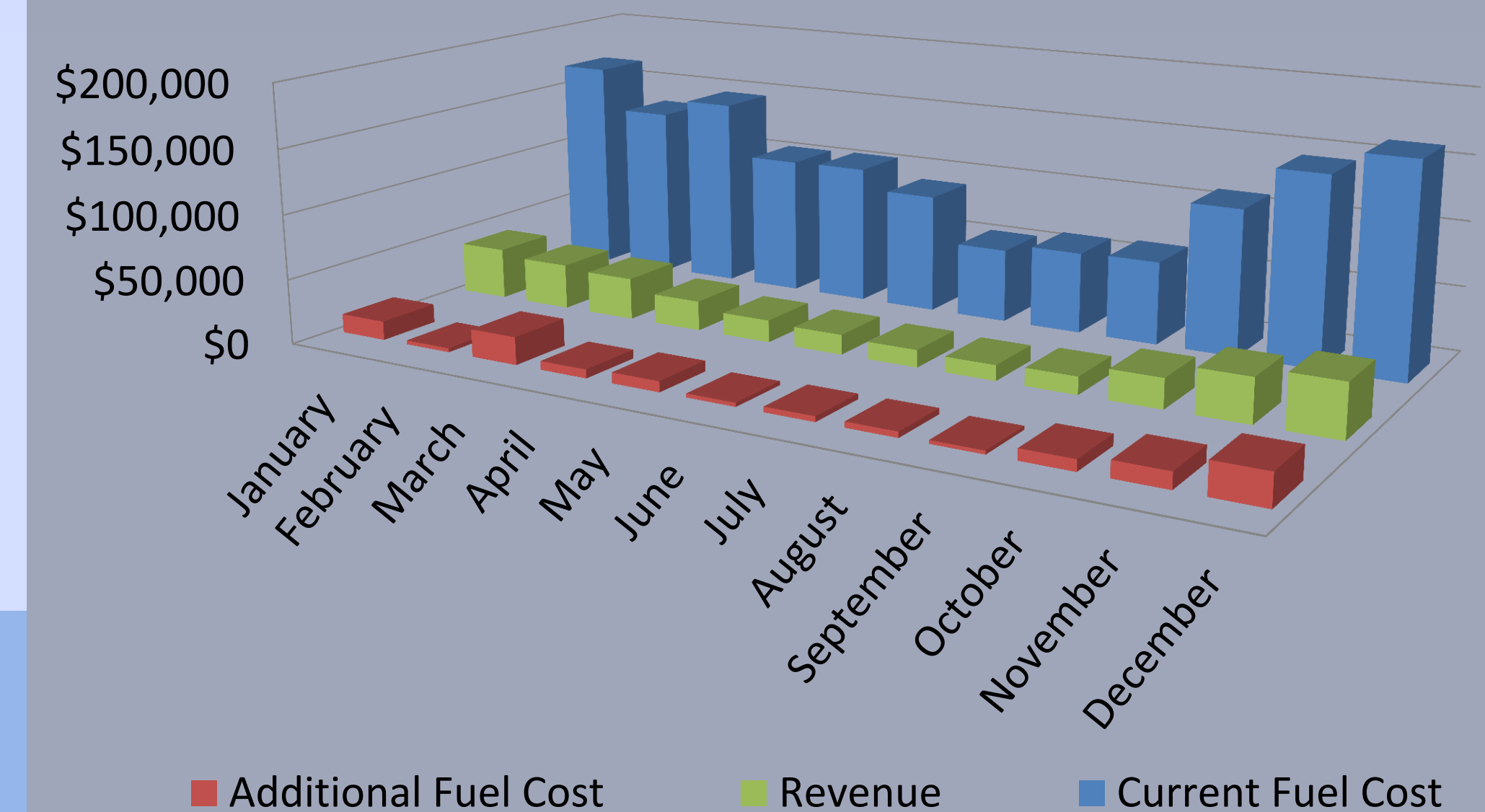
On site generation could produce annual savings of \$170,000/yr through reduced electricity purchases.



Decision criteria, if  $IRR > MARR$ , do the project!

SPP=	7.68 yrs
IRR=	11%
MARR=	6%
Capital Investment=	\$ 1,500,000.00
Market Value=	\$ 5,000.00
Annual Revenues=	\$ 298,546.55
Additional Fuel cost=	\$ 112,724.87
Yearly Maintenance=	\$ 9,500.00
5 Year Maintenance	\$ 37,500.00
Study Period=	30yr

Cogeneration System Fuel Cost and Revenue



## Step 2: Engineering Design Analysis

Six turbine design options were proposed. The three most promising are shown below. The Simple Turbine Model was selected.

Attribute	Simple Turbine Model Single Back-Pressure Turbine	Reheat Turbine Model Reheat Loop Back-Pressure Turbine	Plummer Model Multi-Stage Full Condensing Turbine
Peak Generation	940 kW	2200 kW	5500 kW
Average Generation	580 kW	1400 kW	5800 kW
Annual Savings	\$170,000	\$475,000	\$510,000
Operational Profile	Steam Flow Follows Campus Demand	Steam Flow Follows Campus Demand	Imposes Constant Flow Rate
System Modifications	Turbine	Two Turbines	Turbine
		Facility Expansion	Facility Expansion
		New Boiler	New Boiler
Additional Fuel Consumption and Costs	1,300 BDT 24,000 Therms \$100,000	3,800 BDT 100,000 Therms \$300,000	Full Condensing Loop
			21,000 BDT
			1,750,000 Therms \$2,300,000

